

A Prospective Study of Giardiasis and Water Supplies in Colorado

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Abstract: A prospective study of 484 visitors to Vail and Aspen/Snowmass, Colorado, was conducted to determine the risk of acquiring giardiasis. Of the 259 visitors to Vail, no cases of giardiasis were confirmed and only one of 12 water filtrates was positive for *Giardia* cysts. Of 225 visitors to Aspen/Snowmass two cases of giardiasis were confirmed and 12 of 20 water filtrates were positive for *Giardia* cysts. The regular occurrence of *Giardia* cysts in Aspen and Snowmass water was associated with lower rates of giardiasis acquisition than reported during outbreaks of waterborne giardiasis. (*Am J Public Health* 1987; 77:354-355.)

Introduction

During late 1979, we observed that morphologically intact *Giardia* cysts were detectable in the finished drinking water of the town of Estes Park, Colorado for several months after an outbreak of giardiasis had subsided.¹ In early 1980, staff of the Colorado Department of Health conducted a prospective study of visitors to two resort areas to determine the risk of developing giardiasis and its relation to the presence of *Giardia* cysts in the drinking water.

Methods

Two hundred fifty-nine persons, mainly physicians and dentists and their spouses, were recruited for this study on the first day of one-week medical conferences held in Vail in January and February. Two hundred twenty-five persons were recruited similarly in Aspen or Snowmass.

Persons who agreed to participate in the study were asked to complete questionnaires and to collect two stool specimens—the first on the first day of the conference and the second, one month after their return home, or upon developing diarrhea, whichever came first. Initial questionnaires were completed during the participants' stay at the resort. The last questionnaire was completed one month after the participant returned home.

Stool specimens were preserved in separate vials containing formaldehyde and polyvinyl alcohol (PVA). First stool specimens (S1) were stored; second stool specimens (S2) were examined at the Colorado Department of Health laboratory on receipt. If *Giardia lamblia* cysts or trophozoites were seen on the S2, S1 was then examined. The PVA preservative had gelled in 257 (79 per cent) of 325 S2 specimens; for those specimens only a formalin-preserved stool was examined.

Finished water from the Vail, Aspen, and Snowmass city and town water supplies, and from each mountain restaurant with a separate water supply was collected at least twice-

weekly during the study period and monitored for bacterial content, turbidity, temperature, and free-chlorine residual. Water supplies were filtered weekly for identification of *Giardia* cysts by passing at least 1,000 gallons through one micron wound Orlon filters.² The filters were examined for the presence of *Giardia* cysts at the Colorado State University, Fort Collins, by Dr. Charles Hibler.

Results

Reported rates of diarrhea (three or more stools per day for at least one day, with onset at least one day after arrival to the resort) were 12 per cent (31 of 259) for Vail participants and 5 per cent (11 of 225) for Aspen/Snowmass participants. Symptoms of illness, similar among all ill participants, included abdominal cramps and distention. Fever was reported in fewer than 10 per cent of cases. The median duration of illness was three days (range one to 14); median dates of onset were five days after arrival in Vail and three days after arrival in the Aspen/Snowmass area. Four Vail participants and one Aspen participant developed illness with onset seven or more days after arrival and lasting seven days or more, that is, resembling the illness seen in waterborne giardiasis outbreaks.^{3,4}

Illness was not related to drinking from any specific water source, or to the total amount of water consumed. Diarrhea was more often reported by those with a past history of irritable bowel syndrome, ulcer disease, or chronic gastritis. None of numerous other factors examined—including age, sex, geographic area of residence, history of giardiasis, self-reported alcohol consumption, or history of travel to various areas of the world—was associated with the development of diarrhea.

Among the 42 participants with diarrhea, 29 submitted both a first and second stool specimen. One of 151 Aspen/Snowmass participants who submitted stool specimens was positive for *Giardia lamblia* on S2 and negative on S1; this person did have diarrhea. Another Aspen/Snowmass participant who did not submit stool specimens was diagnosed as having giardiasis, with a positive stool specimen, by his private physician within the 30-day follow-up period. No Vail participant, among 174 tested, had a negative S1 and a positive S2. Two Aspen/Snowmass participants and one Vail participant were positive on both their S1 and their S2; none had diarrhea. Apparently, they were asymptomatic carriers.

The Vail town water was positive for *Giardia* cysts on none of nine occasions tested during the study period; the Vail mountain restaurants' water was positive on one of three occasions. The Snowmass town water was positive on four of four occasions; the Aspen town water on three of five occasions; and the Aspen/Snowmass area mountain restaurants' water supplies on five of 11 occasions. All water supplies monitored had acceptable coliform, turbidity, and chlorine levels throughout the study period.

Discussion

Most of the diarrheal illnesses reported had an early onset and were of short duration, thus being not typical of giardiasis. Moreover, the occurrence of diarrhea was not related to the amount or source of the water consumed within either group. Both persons with documented giardiasis were

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in the Aspen/Snowmass group, and *Giardia* cysts were detected in the Aspen/Snowmass water supplies much more frequently than in the Vail water supplies.

Our methods might have led to an underestimate of the proportion of persons positive for *Giardia*. According to published reports, a single stool specimen has only about a 60 to 70 per cent chance of detecting *Giardia* when it is present.^{5,6} Thus we can estimate that possibly seven persons had a positive S2. Another potential problem was the congealed PVA specimens in a large number of submissions. Staff at the Colorado Department of Health laboratory determined in a separate study of consecutive paired specimens that only 4 per cent (three of 82) of persons with giardiasis were positive on the PVA-preserved specimen and not on the formalin-preserved specimen. Thus, it is not likely that a large number of positives were missed. A third potential problem was that if the timing of collecting S2 was less than optimal, we might have missed some positives. Of the 29 ill participants who collected stool specimens, only two subjects submitted S2 less than two weeks after their arrival date and only three participants submitted S2 more than 36 days after they left the resort. Since the interval between ingestion of *Giardia* cysts and detection of cysts in the stools ranges from 10–36 days,⁷ collection times should have been close to optimal for most participants.

The two persons whose S1 was negative and S2 was positive may have acquired *Giardia lamblia* from drinking treated water in the Aspen/Snowmass area. Yet, when compared to previously reported attack rates (4–18 per cent) for four outbreaks of giardiasis in which *Giardia* cysts were identified in potable water,^{8–11} the rate of *Giardia* acquisition for Aspen/Snowmass participants was low: 1/151 or 0.7 per cent for those who submitted stools and 2/224 or 0.9 per cent overall.

Cysts identified during this investigation may have been non-pathogenic strains, may have been present in insufficient quantities to infect most persons, or may have been killed by chlorine. It was also possible that the cysts were incorrectly identified as those of *Giardia lamblia*. Current technology

does not allow determination of the number of *Giardia* cysts present per volume of finished water,¹² nor can we reliably determine whether these cysts are viable or pathogenic for humans. Future development of methods that will provide this information are greatly needed and are necessary to determine whether treated surface water is indeed safe to drink.

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